Confidential

Project Requirements

Mini-Solar Power Station

SD1203

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Requirements Capture

1. Introduction

1.1 Definitions

TBD – To Be Determined
AC – Alternating Current
DC – Direct Current
MCU – Microcontroller
DAQ – Data Acquisition
ADC – Analog to Digital Converter
RTC – Real Time Clock
PVC – Polyvinyl Chloride

1.2 Project Description

The Mini-Solar Power Station will consist of two subprojects. The first subproject will contain a satellite dish covered with a reflective surface aimed at the sun. The satellite dish will track the sun ensuring that the maximum amount of sun rays will be collected at all times. The reflective surface on the dish will focus all the sunlight to the dish's focal point. A hollow copper coil tube, which contains continuously running fluid, will be placed at the focal point. As the sunrays are reflected and focused at the copper coil tube, essentially at one point, the copper coil will begin to heat up which will consequently heat the fluid inside the coil. Thermal insulated tubing will connect the copper coil to a heat exchanger and a sterling engine, so that the heat from the liquid can be collected and transfer into kinetic energy. The sterling engine will drive an electrical generator. The heat will be converted to AC electricity and then converted to DC in order to charge two 12-volt batteries. The batteries will run a 300-watt inverter, which can be a used as a power source for some common household appliances.

The second subproject includes constructing a mechanical fixture containing a heat/light source, figure 1, to simulate the rising, setting, and latitudinal movements of the sun. The fixture will be used in correspondence with the above-mentioned satellite dish. A high wattage heat lamp will be used to represent the sun and will be the source of heat. The heat lamp will include a dimmer switch, which will dim the heat lamp to represent cloud cover. Temperature data is to be collected and plotted in MATLAB. With the dimming of the lamp, the decrease in temperature should be evident in the MATLAB plotted data. The final goal of the project is to have the satellite mini-solar power station fully functional outside using natural sunlight.

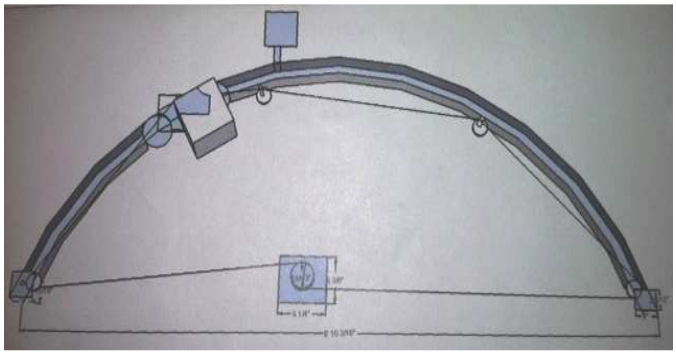

Figure 1

2. Project Requirements

2.1 Design Specifications

2.1.1 Design, construction, and implementation will be up to the group and is subject to change via a group decision. The group will have weekly meetings with the advisors every Friday at 2:00pm.

2.2 Electric Drives

2.2.1 Solar Collector

2.2.1.1 Two stepper motors will be used to track the movement of the sun. One motor will control motion of the dish in the x direction (latitude) and one motor will control its motion in the y direction (longitude).

2.2.2 Sun Simulator

2.2.2.1 One motor will be a linear actuator, which will operate very slowly moving the heat bulb along the PVC arch, simulating the rising and setting of the sun. The second motor will be a stepper motor that will provide 15 degrees of tilting in two directions for the PVC track, simulating the latitudinal movement of the sun.

2.3 Heat and Electricity Conversion

2.3.1 Solar Collector

2.3.1.1 Heat will be converted using a heat exchanger in the form of a small radiator from a car heater and the heat will be converted into mechanical energy using a sterling engine. Finally, the energy will be converted into electricity by driving an electric generator.

2.3.1.2 An inverter will be purchased.

2.4 PIC18 MCU

2.4.1 Solar Collector

2.4.1.1 The MCU will control both steppers motors. The dish will be made to track the movement of the sun (and heat lamp) using two or three photocells (light sensitive resistors) combined with comparator circuits and applicable coding. Coding will be done in C or LabVIEW.

2.4.2 Sun Simulator

2.4.2.1 The MCU will control the stepper motor. The motor will turn on at a certain preset time and slowly move the heat lamp until another preset time, making use of MCU RTC. Soon after, the motor will move the lamp back to the starting position ready for next day simulation. MCU will also provide speed control of the motor via a potentiometer or a similar type device, to speed or slow

down bulb movement. The MCU will control the stepper motor, adjusting the angle of rotation. The angle of rotation can be set using a potentiometer or similar type device.

2.4.2.2 The MCU will (potentially) control the dimmer switch connected to the heat baluster using a potentiometer or similar type device. All coding will be done in C or LabVIEW.

2.5 Data acquisition and Monitoring

2.5.1 Solar Collector

2.5.1.1 A data logger (DAQ) circuit will log data and display the results on a graph.

2.5.1.2 The graphing software will be MATLAB (or equivalent) to display temperature and/or power over time.

2.5.1.3 The launching of the tracking function will be controlled via a light intensity monitor. The light intensity monitor will turn the tracking function on when the sunlight intensity is above a preset level, and turn the function off when the sunlight intensity drops below the preset level. This will ensure that the system will shut off during night or circumstances like cloudy or rainy days that does not provide enough solar power to generate the power to supply the system itself. The light intensity monitor will (possibly) be implemented using a photo resistor, a comparator, and the MCU accompanied with proper code.

2.6 Mechanical Fixture

2.6.1 Solar Collector

2.6.1.1 The project will use a standard mega satellite dish (one used for television).

2.6.1.2 Space blanket (survival sheet or Mylar covering) will be adhered to the inside of the satellite dish to create a reflective surface.

2.6.1.3 ¼" copper tubing will be used for copper coil.

2.6.1.4 ¼"-1" plastic insulated tubing will be used to connect copper coil and heat exchanger or sterling engine.

2.6.1.5 The satellite will be mounted on a platform made of wood, plastic, or metal. The platform will be secured to the actuator motor moving the satellite in the y direction. The base of the satellite will be mounted on a platform made of wood, plastic, or metal. The platform will be secured to the second actuator motor moving the satellite in the x direction.

2.6.2 Sun Simulator

2.6.2.1 Arch material will be made of 10' long 1-1.5" PVC tubing.

2.6.2.2 Cable will be coiled around a tube, which will be connected to the actuator motor to move the heat bulb across the arch.

2.6.2.3 The connection device of bulb to PVC arch will be constructed in the tool room.

3. Project Summary

The goal of this project is to create a new and innovative method of harnessing energy, in the form of heat, from the sun. We intend to convert this energy into electricity using a heat exchanger and a sterling engine. Once the heat is converted to AC electricity, it will be converted to DC which will charge two 12 volt batteries. The two 12 volt batteries will then run a 300 watt inverter. This ingenious approach will prove to be challenging. It will require each group member to work independently and collaboratively while utilizing previously learned information and expanding technical competencies through research and development.